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INSTRUCTION MANUAL

MODEL 242

REGULATED HIGH VOLTAGE SUPPLY

KEITHLEY INSTRUMENTS

INSTRUCTION MANUAL

MODEL 242

REGULATED HIGH VOLTAGE SUPPLY

WARRANTY

We warrant each of our products to be free from defects in material and workmanship. Our obligation under this warranty is to repair or replace any instrument or part thereof (except tubes and batteries) which, within a year after shipment, proves defective upon examination. We will pay domestic surface freight costs.

To exercise this warranty, call your local field representative or the factory, DDD 216-795-2666. You will be given assistance and shipping instructions.

REPAIRS AND RECALIBRATION

Keithley Instruments maintains a complete repair service and standards laboratory in Cleveland, and has an authorized field repair facility in Los Angeles.

To insure prompt repair or recalibration service, please contact your local field representative or the plant directly before returning the instrument.

Estimates for repairs, normal recalibrations, and calibrations traceable to the National Bureau of Standards are available upon request.

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*Change Notice

*Yellow Change Notice sheet is included only for instrument modifications affecting the Instruction Manual.

SECTION 1. GENERAL DESCRIPTION

1-1. GENERAL. The Keithley Model 242 Regulated High Voltage Supply provides accurate, stable outputs between 300 and 3500 volts dc. Accuracy is ±0.1% for all loads up to 25 milliamperes. Stability is ±0.01% for six months after a 30-minute warm-up. Line regulation is within ±0.005% for a 10% change in line voltage, and load regulation is within ±0.005% from zero to full load.

1-2. FEATURES.

a. Four in-line calibrated dials set the output voltage in 1-volt steps. A TRIM Control interpolates between steps with resolution better than 15 millivolts. Output can be selected positive or negative, or floated up to 1000 volts off chassis ground.

b. Cumulative drift is prevented by a chopper circuit with a temperature-compensated zener diode reference, a photo-modulator comparator and wirewound sampling resistors.

c. The Model 242 uses heavy duty thermionic rectifiers, a maintenance-free photo-modulator and epoxy encapsulated power transformers. All high voltage capacitors are of oil-filled, metal-cased construction with mylar dielectric.

1-3. APPLICATIONS. The Model 242 is an excellent source for phototubes, photo-multiplier tubes and other detectors requiring high voltage biasing with superior stability. Its current capability permits parallel operation of photo-multiplier divider strings. Other applications include use in calibration tests, voltage gradient studies, insulation tests and leakage resistance measurements.

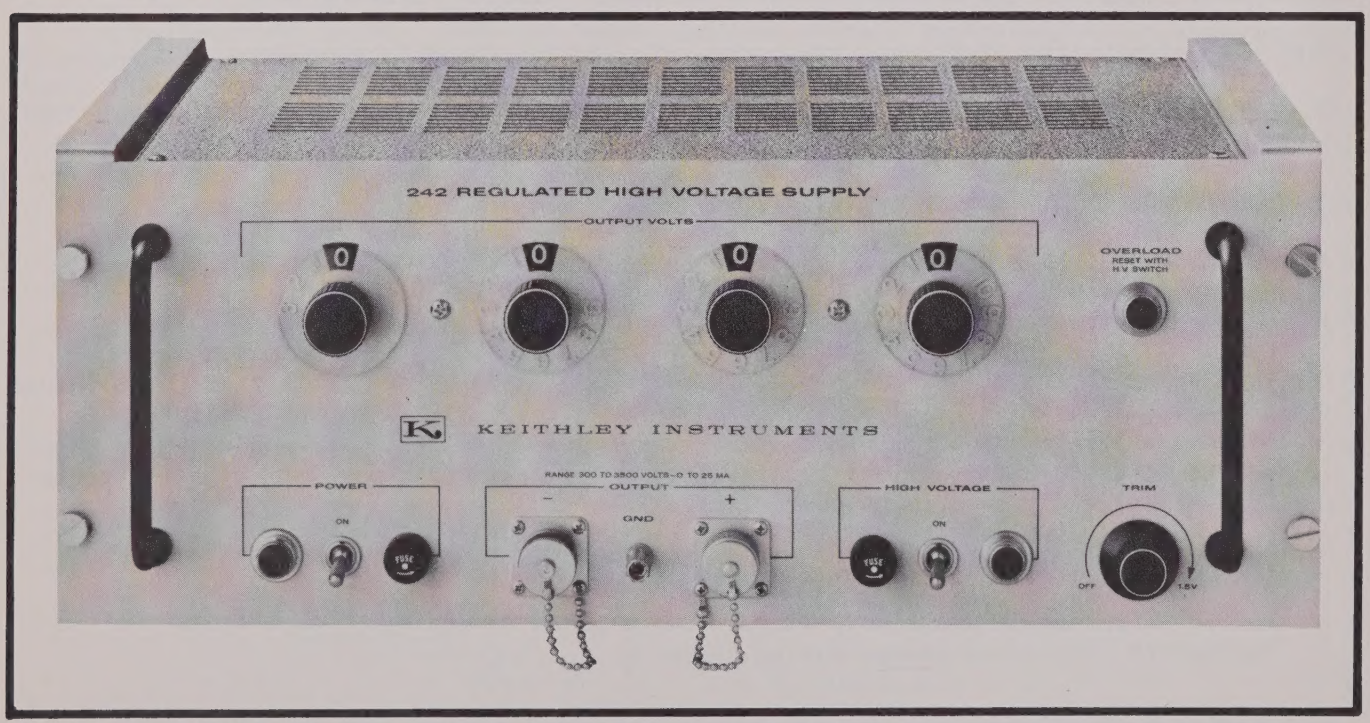

FIGURE 1. Keithley Instruments Model 242 Regulated High Voltage Supply. The Voltage Supply is shown with the Model 2421 End Frames, for bench use.

1-4. SPECIFICATIONS.

OUTPUT:
Voltage: 300 to 3500 volts dc in 1-volt steps.
Current: 25 milliamperes dc maximum.
Polarity: Positive or negative.
Floating: 1000 volts maximum off chassis ground.

ACCURACY: ±0.1% of dial setting.

RESOLUTION: A TRIM Control permits interpolation between steps with a resolution of better than 15 millivolts.

RESETABILITY: ±0.01%.

STABILITY: ±0.01% per 6 months after a 30-minute warm-up.

TEMPERATURE COEFFICIENT: ±15 ppm/°C maximum.

LINE REGULATION: ±0.005% for 10% change in line voltage.

LOAD REGULATION: ±0.005% from zero to full load.

RIPPLE AND NOISE: Less than 2 millivolts rms above 5 cps.

OVERLOAD PROTECTION: Output is disconnected within 25 milliseconds if current exceeds approximately 27 milliamperes.

CONNECTORS: Output: Two Teflon-insulated hn type. Ground: Binding post.

POWER: 105-125 volts, 50-60 cps, 250 watts. 210-250 volt models available.

DIMENSIONS, WEIGHT: 7 inches high x 19 inches wide x 13-1/4 inches deep; net weight, 39 pounds.

ACCESSORIES SUPPLIED: Mating connectors.

1-5. ACCESSORIES. The Model 242 is designed for rack mounting and requires the Model 2421 End Frames for bench use. The pair of end frames, which comes with feet and mounting hardware, fastens to the Voltage Supply sides and front panel.

1-6. EQUIPMENT RECEIVED. The Model 242 Voltage Supply is factory calibrated. Two vacuum tubes, the 7235 (V4, Figure 10) and the 4-65A (V12, Figure 8) are packed separately to prevent damage during shipping. Both output receptacles are capped, one with a red shorting cap and the other with a plain protective cap. The shipping carton also contains the Instruction Manual and two mating output plugs.

NOTE

Before shipping the Model 242, always remove tubes V8 and V12. Pack these separately to prevent damage during shipping.

SECTION 2. OPERATION

2-1. FRONT PANEL CONTROLS AND TERMINALS (See Figure 2).

a. Voltage Switches. Four skirted dials, calibrated in 1000, 100, 10 and 1-volt steps, set the output voltage from 300 to 3500 volts dc.

b. TRIM Control. The TRIM Control extrapolates between 1-volt settings with a resolution to 15 millivolts. The span of the control is 1.5 volts.

c. POWER Switch. A toggle switch energizes the filament and low voltage supplies to the Model 242. When the Switch is ON, the POWER pilot light will glow green to indicate the instrument is on. The Fuse for the control circuits is next to the Switch.

d. HIGH VOLTAGE Switch. A toggle switch controls the high voltage output circuits and also resets the High Voltage Supply after an overload. The amber pilot light indicates the HIGH VOLTAGE Switch is ON. When the Switch is off, the high voltage output is disconnected, although the filament and low voltage circuits continue operating. The Fuse for the high voltage circuit is next to the Switch.

e. OUTPUT Receptacles. Two hn-type receptacles (UG 496/U) are on the front panel, marked for negative (-) and positive (+) outputs with respect to the chassis. The ground post (GND) is between the receptacles. The red cap is a shorting cap to ground the unused receptacle during normal operation. The other cap protects the receptacle when the Model 242 is not operating.

f. OVERLOAD Pilot Light. When the output current exceeds approximately 27 milliamperes, the overload relay opens the high voltage output circuit and lights the red OVERLOAD Pilot Light. The Pilot Light also lights for settings below 300 volts.

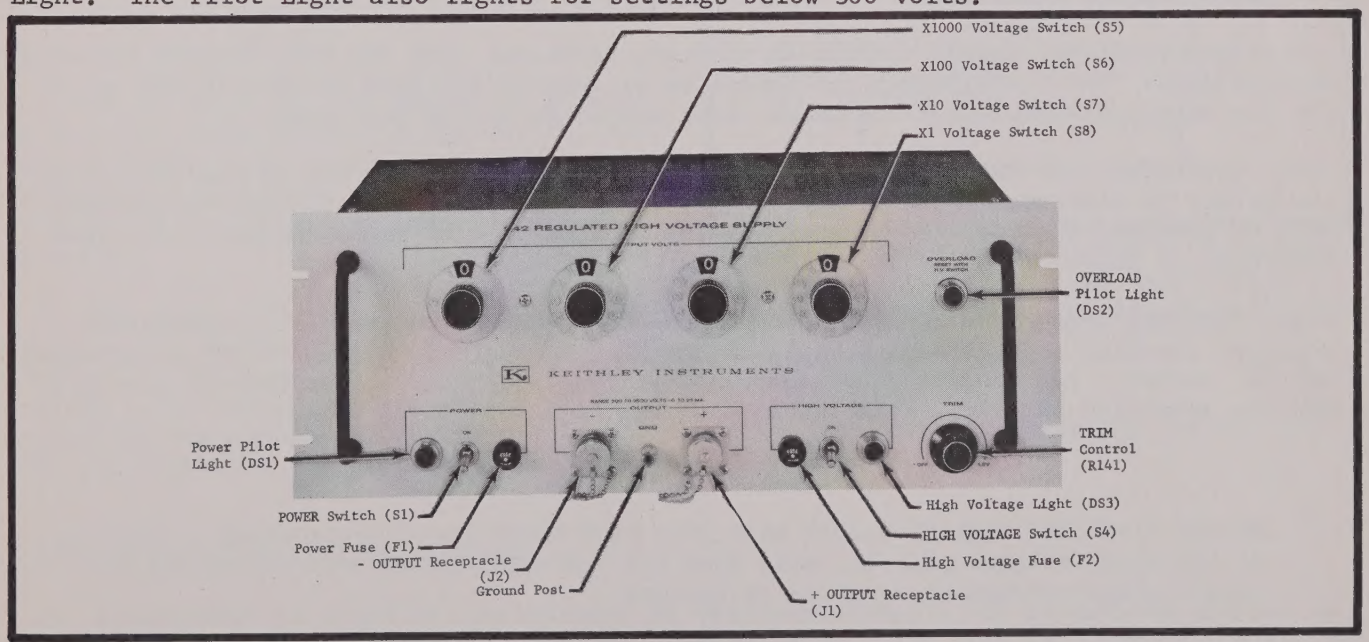

FIGURE 2. Model 242 Front Panel Controls and Terminals. Circuit designations refer to Replaceable Parts List and the schematic diagram.

2-2. OPERATING PROCEDURES.

a. Keep the POWER Switch, HIGH VOLTAGE Switch and TRIM Control off. Connect the power cord at the back of the cabinet to an outlet. Unless otherwise specified on the instrument, the Model 242 connects into 105-125 volt, 50-60 cps sources.

b. Connect the load to the Model 242. For positive polarity output, connect the cable to the + OUTPUT Receptacle; connect the red shorting cap to the - OUTPUT Receptacle to ground the negative line. The + OUTPUT Receptacle has its center terminal at positive polarity and its shell at chassis ground. Reverse procedures for negative polarity output.

c. Set the POWER Switch to ON. Select the output voltage by setting the four Voltage Switches between 300 and 3,500 volts.

NOTE

Make sure the TRIM Control is set to OFF. If it is on, up to 1.5 volts will be added to the displayed output.

d. Warm up the Model 242 for 30 seconds. Put the HIGH VOLTAGE Switch in ON position. Warm up the Model 242 for approximately 30 minutes for maximum output stability.

NOTE

The OVERLOAD Pilot Light will light if the HIGH VOLTAGE Switch is ON when the POWER Switch is turned on. OVERLOAD will also light if the circuits are not warmed up. When the OVERLOAD bulb lights, put the HIGH VOLTAGE Switch off and wait 30 seconds. Then put on HIGH VOLTAGE Switch again.

e. If desired, use the TRIM Control for settings between the 1-volt steps. Resolution is better than 15 millivolts.

f. When resetting output voltage or changing terminals, put the HIGH VOLTAGE Switch to OFF position. The POWER Switch can remain on as long as the HIGH VOLTAGE Switch is off for the output change. Only the green light should be on for this step.

2-3. OVERLOADS. If the red OVERLOAD Pilot Light lights, the circuit is overloaded and the output is disconnected. To reset the Model 242, snap the HIGH VOLTAGE Switch off, wait 30 seconds, then put it on again. Refer to Section 4 if the OVERLOAD Pilot Light continues to light.

2-4. FLOATING OPERATION. Remove the shorting cap from the receptacle. Connect two separate shielded coaxial cables, type RG-149/U or equivalent, to the OUTPUT Receptacles, one for positive and one for negative polarity. Use only the two furnished connectors and the specified shielded cables because of the high potentials present.

NOTE

Do not float the Voltage Supply more than 1000 volts off chassis ground. Because of the high voltages present, make sure all instructions are understood and followed before attempting floating operations.

SECTION 3. CIRCUIT DESCRIPTION

3-1. GENERAL. The Keithley Model 242 Regulated High Voltage Supply furnishes accurate, stable outputs from 300 to 3500 volts dc. The block diagram, Figure 3, shows the relationship between the operating circuits. Setting the sampling resistors in the divider selects the output voltage. The maintenance-free photo-modulator compares a portion of the output to the zener diode reference. The difference is amplified and used to control the series regulator tube. This maintains the output voltage constant at a level determined by the divider ratio selected with the front panel Voltage Switches.

NOTE
Refer to Schematic Diagram 14661D for circuit designations.

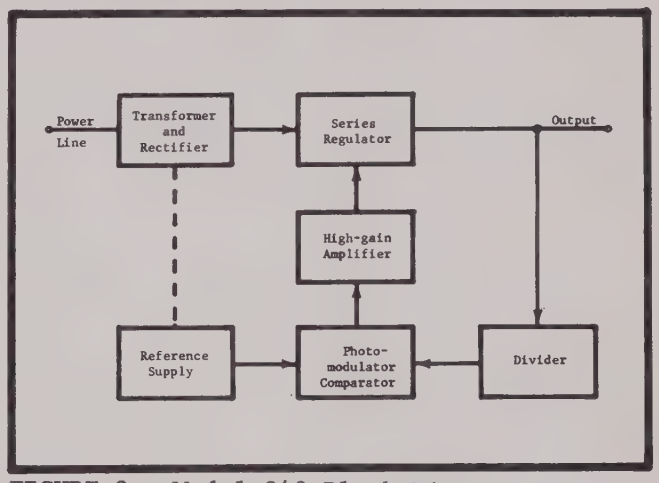

FIGURE 3. Model 242 Block Diagram.

3-2. AC CONTROL CIRCUITS. (Refer to Figure 4.)

a. Closing the POWER Switch, S1, completes the circuit from the power line to transformer T1, which furnishes the bias voltages, and to filament transformer T3. If the HIGH VOLTAGE Switch, S4, is off, the control relay, K2, will close. The circuit to transformer T2, which supplies high voltages to the series regulator, can now operate when the HIGH VOLTAGE Switch is turned on.

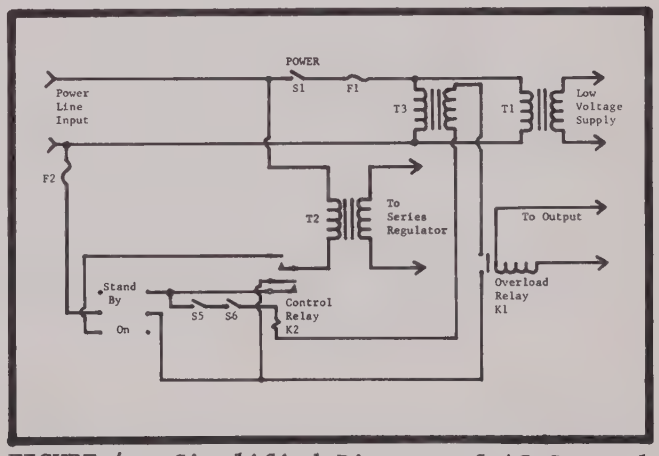

FIGURE 4. Simplified Diagram of AC Control Circuits. All circuits are shown open. Circuit designations refer to schematic diagram.

b. If the HIGH VOLTAGE Switch is already ON when the POWER Switch is put ON, the circuit activating the control relay is open. Therefore, transformer T2 can not function, even though the other two transformers are operating.

c. The Model 242 has several safety devices in its ac control circuits. The overload relay, K1, breaks the circuit to the control relay and to transformer T2 if the output current exceeds approximately 27 milliamperes. The decade interlocks, S5 and S6, will not close for outputs less than 300 volts.

3-3. LOW AND HIGH VOLTAGE SUPPLIES.

a. Transformer T1 supplies low voltages to bias the circuits and to furnish the voltage for the zener diode reference. A separate winding, along with tube V9, provides regulated 105 volts to the screen of the series regulator tube, V12. The transformer also provides

the gating voltage for the diode bridge demodulator, D106 to D109.

b. Transformer T2 supplies the high voltages for the series regulator. The transformer primary is tapped to furnish a different voltage for each 1000-volt range. This prevents exceeding the voltage and power rating of the series regulator, V12, under any of the specified line and load conditions. Two rectifiers, tubes V10 and V11, convert the transformer output to full-wave rectified dc for the series regulator, V12.

3-4. REGULATOR CIRCUIT. (See Figure 5.)

a. The regulator circuit uses a photo-modulator to compare the output voltage to the selected voltage. Any difference is amplified and returned to the series regulator to correct the output.

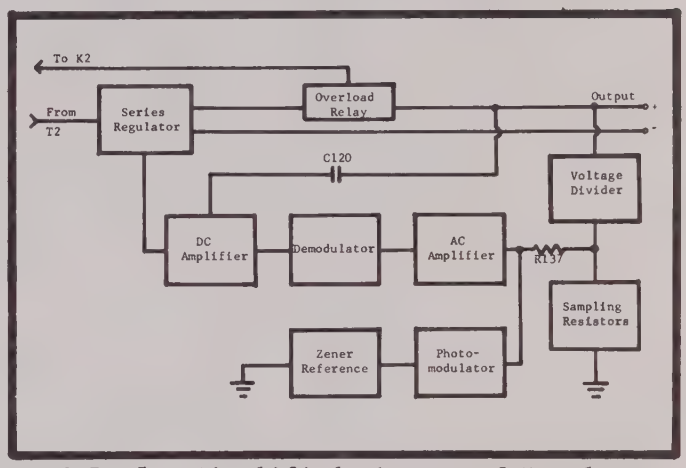

FIGURE 5. Simplified Diagram of Regulator Circuit.

b. For low-frequency fluctuations at the output, the voltage divider and the sampling resistors on the decade switches divide the output voltage. The photo-modulator, E101, compares the reference voltage across zener diode D103 and the divided output voltage. The photo-modulator develops an ac signal for any dc voltage difference. The signal is then amplified by tube V2 and demodulated by the diode bridge, D106 to D109. The dc signal is further amplified by V3 and V4 and applied to the bias of the series regulator tube, V12.

c. For high-frequency fluctuations and transients in the output, the feedback loop is through capacitor C120 to the grid of tube V4, which applies the signal to the bias of the series regulator tube, V12.

d. The voltage switching is done by current sensing, which means no switch contact is required to carry more than 5 milliamperes or switch more than 9 volts.

SECTION 4. SERVICING

4-1. GENERAL. Section 4 contains the maintenance and troubleshooting procedures for the Model 242 Voltage Supply. Follow these as closely as possible to maintain the specifications of the instrument.

4-2. SERVICING SCHEDULE. The Model 242 requires no periodic maintenance beyond the normal care required of high-quality electronic equipment. Occasional checks of the output, described in Section 5, will show the need for any adjustments. No part should need frequent replacement under ordinary use.

4-3. PARTS REPLACEMENT.

a. The Replaceable Parts List in Section 6 describes the electrical components of the Voltage Supply. Replace components only as necessary. Use only reliable replacements which meet the specifications.

b. The zener diode, D103, is selected. Diodes D104 and D105 are matched; replace only as a pair. Order these replacements only from Keithley Instruments, Inc., or its representative, as well as other parts marked for Keithley manufacture in the Replaceable Parts List.

4-4. TROUBLESHOOTING.

a. The procedures which follow give instructions for repairing troubles which might occur in the Model 242. Use the procedures outlined and use only specified replacement parts. Table 1 lists equipment recommended for troubleshooting. If the trouble cannot be located or repaired, contact Keithley Instruments, Inc., or its representative.

Instrument	Use
Keithley Instruments Model 153 Microvolt-Ammeter, 1% accuracy at 100 millivolts	Zener circuit adjustment
Tektronix Type 503 Oscilloscope, 1 mv/cm sensitivity, dc to 450 kc	Adjust bias
dc voltmeter, 10% accuracy, to 4000 volts, 10-megohm minimum input resistance	Measure dc voltages
Grid-modulated tube tester	Test vacuum tubes
10-ohm, 1/2 watt, 1/2% deposited carbon resistor (Keithley Part R12-10)	Zener circuit adjustment
NE-1 neon tube; 1/2 watt, 1/2% deposited carbon resistor; 0.5-microfarad, 4000-volt capacitor	Adjust bias

TABLE 1. Equipment Recommended for Model 242 Troubleshooting. Use these instruments or their equivalents.

Trouble	Probable Cause	Remedy
No output	Blown fuse, F1 or F2	Replace fuse; if fuse again blows, check further
	Defective V10, V11, R113 or C106	See paragraph 4-6
	Defective series regulator V12	See paragraph 4-6
Output voltage not stable	Defective C115	Check capacitor; replace if faulty
Output voltage not accurate	Power Supply out of calibration	Recalibrate per paragraph 5-3
	Improper zener adjustment	See paragraph 4-7
Excessive noise in output	Bias out of adjustment	See paragraph 4-8
Overload circuits cuts off with no overload	Defective R118 or K1	See paragraph 4-9
	Defective C115	Check capacitor; replace if faulty
Voltage Supply operates even when overloaded	C116 shorted	Check capacitor; replace if faulty

TABLE 2. Model 242 Troubleshooting. Read paragraph 4-5 before performing any repairs.

b. Table 2 lists problems which might occur. If the repair indicated does not work, check through each circuit as described in the following paragraphs. Refer to the circuit description in Section 3 to find the more crucial components and to determine their function. The complete circuit diagram, 14661D, is in Section 6.

4-5. PROCEDURES TO GUIDE TROUBLESHOOTING.

a. Before troubleshooting the Voltage Supply, check the external circuits. Check the fuse, power cord and power source. The Schematic Diagram indicates the tube element voltages referenced to chassis ground. Measure the dc voltages to ±10% of the indicated values.

b. Check the vacuum tubes. Normally, replacing tubes will clear up any difficulty. All tubes except V4, V10, V11 and V12 are readily tested on a grid-modulated tube tester. Check the remaining four tubes by replacing them.

NOTE

Before removing the top or bottom cover, make sure the power cord is disconnected. After removing the cover, discharge all metal-cased capacitors before proceeding with repairs. Discharge all high voltages through a bleeder.

c. Remove the Model 242 covers. Do not put a load on the instrument. Put the red

shorting cap on the - OUTPUT Receptacle. Set the Voltage Switches for a 300-volt output; make sure the TRIM Control is off. Put on the POWER and HIGH VOLTAGE Switches, as outlined in paragraph 2-2.

NOTE

Be careful working inside the chassis. If the POWER Switch is on, up to 200 volts may appear at points in the control circuits. High voltage appears on both sides of the chassis. Before working on a faulty Voltage Supply, disconnect the power cord and discharge all filter capacitors, as C106 and C115.

4-6. CORRECTING FOR NO OUTPUT.

a. Check both front panel fuses. The HIGH VOLTAGE Pilot Light indicates when it is possible to have a high voltage output; however, it can light even when the fuse is blown. Replace defective fuses. If the fuse again blows, check further for the cause.

b. Measure the plate voltage of series regulator tube V12. Use a dc voltmeter which measures to 4000 volts. Make sure the Voltage Switches are set at 300 volts before making this measurement. The plate voltage should be 2000 volts ±20%.

NOTE

Discharge high voltage from tube V12 through a bleeder. Discharging the cap directly to the chassis may damage resistor R113 or diode D101.

c. If the plate voltage is not correct, check rectifiers V10 and V11, the series resistor R113 (Figure 11), the filter capacitor C106 (Figure 8) and the primary winding of transformer T2 (Figure 8) for 117 volts ac. If no voltage appears on the transformer primary, check the overload relay, K1 (Figure 10), and the control relay, K2 (Figure 8).

d. If the plate voltage of tube V12 is correct, check the cathode voltage across pin 1 or 7 to ground. The voltage should be 300 volts ±10%.

e. Incorrect voltage at the cathode indicates tube V12 is faulty or incorrect biasing conditions exist. If the voltage is still not correct after tube V12 is replaced, check tube V4 (Figure 10), the dc amplifier tube V3 (Figure 10), the ac amplifier tube V2 (Figure 10), and the diodes in the demodulating bridge, D106 to D109 (Figure 10).

f. If the plate voltage of V12 is correct, check the overload relay K1. Refer to paragraph 4-9.

4-7. CORRECTING FOR INACCURATE VOLTAGE OUTPUT. Poor regulation or excessive drift will affect the accuracy of the voltage output. Several factors cause this; check the following.

a. A defective capacitor C115 (Figure 8) will cause the output to be unstable.

b. Although it normally does not need replacement, check the zener diode D103 (Figure 8). Since adjusting the diode circuit requires recalibrating the entire instrument, check the zener diode only after all other possible trouble sources are eliminated.

1. Remove the jumper in series with diode D103 (the jumper is next to R133, Figure 9).

Connect a 10-ohm, 1/2% resistor (Keithley Part No. R12-10) at this point. Read the voltage across the resistor with the Model 153. Adjust the ZENER ADJ potentiometer, R133 (Figure 9), until the microvoltmeter reads the product of the rated zener current (7.5 milliamperes) times the resistance (10 ohms) or 75 millivolts ±1%.

2. The voltage across the zener diode should now be between 8.55 and 9.45 volts. If this voltage is not correct, check the regulator tube V1 (Figure 10), resistor R132 (Figure 11), the ZENER ADJ potentiometer R133 and the zener diode D103.

3. After adjusting the voltage, recalibrate the Model 242 (paragraph 5-3).

4-8. BIAS ADJUSTMENT.

a. Connect the Model 242 to the circuit shown in Figure 6. Use a resistor which will allow a full load — 25 milliamperes — on the Model 242. For example, set the Voltage Supply to 1000 volts output and use a 25-kilohm resistor. Use a 0.5-microfarad, 4000-volt blocking capacitor in series with the oscilloscope for protection.

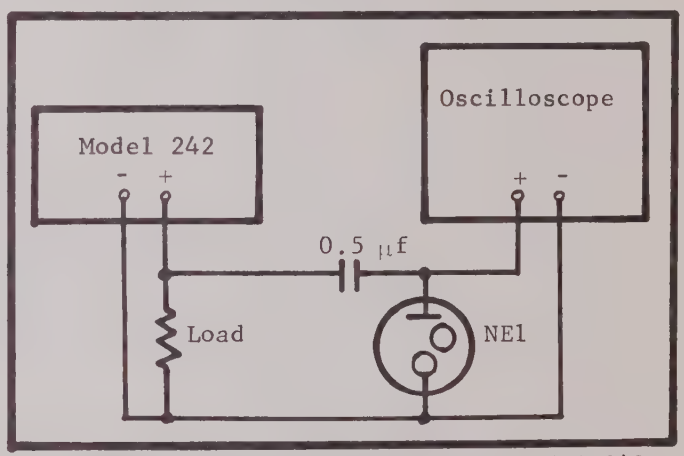

FIGURE 6. Circuit Diagram for Model 242 Bias Adjustment. Refer to paragraph 4-8 for procedures and Table 1 for equipment.

b. Turn the Voltage Supply on; monitor the output on the oscilloscope. The oscilloscope should show a signal with 2-millivolt rms ripple or less. Adjust the BIAS ADJ potentiometer, R144 (Figure 9), until the minimum ripple appears on the oscilloscope.

c. If the potentiometer does not have sufficient range to lessen the noise, check capacitor C108. If capacitor C108 (Figure 10) is open, it will cause excessive noise. If it is good, observe the output wave. A high level of corona indicates the feedback capacitor C120 (Figure 9) is open or the core of transformer T2 (Figure 8) is grounded.

4-9. IMPROPERLY WORKING OVERLOAD.

a. If the OVERLOAD Lamp keeps lighting when the instrument is turned on, turn it off and remove the load. If the instrument works when the load is not present, the overload is in the external circuit. If the instrument continues to show an overload, check the Model 242 for the trouble. Check the circuit voltages against those marked on the Schematic Diagram.

b. If the overload relay K1 (Figure 10) will not break the circuit when the Voltage Supply becomes overloaded, check filter capacitor C116 (Figure 10) for a short and check the overload relay for proper operation.

c. If the overload relay cuts off the circuit with no overload present, check the coil of K1 (Figure 10) against the rated value printed on it. Also check the shunting resistance R118 (Figure 9) to make sure its value has not changed.

d. If previous checks have not located the source, check capacitor C115 (Figure 8). A leaky or shorted capacitor here will cause troubles similar to those caused by a faulty overload circuit.

SECTION 5. CALIBRATION

5-1. GENERAL.

a. The following procedures are recommended for calibrating the Model 242. It is also recommended that the equipment listed in Table 3 be used. If difficulty is encountered, contact Keithley Instruments, Inc., or its representative.

b. This Section covers calibrating the accuracy of the output voltage.

c. If the instrument is not within specifications after the calibration, follow the troubleshooting procedures or contact Keithley Instruments, Inc., or its representative.

5-2. CALIBRATION SCHEDULE. Check the accuracy of the output voltage every six months. Also recalibrate the instrument if the series regulator tube, V12, is replaced. Replacing or adjusting the zener diode, D103, also necessitates recalibrating the output.

5-3. OUTPUT CALIBRATION.

a. Set up the Model 242 according to Figure 7. Use the Model 660A Guarded dc Differential Voltmeter (±0.02% limit of error) and the Model 6601A Divider (±0.01% limit of error). Total limit of error of this system is ±0.03%. The Model 660A Differential Voltmeter may be used directly for output voltages from 300 to 500 volts.

b. Turn on the Model 242. Set the output to 3500 volts; make sure the TRIM Control is off before making the calibration. The voltmeter should read 3500 volts ±3.5 volts. If necessary, adjust the HV ADJ potentiometer, R136 (Figure 9), until the output reads 3500 volts on the Model 660A Voltmeter.

CAUTION

Be careful making internal adjustments. Up to 5000 volts dc and 3600 volts ac are present inside the instrument.

c. Set the Voltage Switches to 300 volts. The voltmeter should read 300 volts ±0.3 volt. If necessary, adjust the LV ADJ potentiometer, R142 (Figure 9), until the output reads 300 volts on the Model 660A Voltmeter.

Instrument	Use
Keithley Instruments Model 660A Guarded dc Differential Voltmeter, ±0.02% limit of error, 100 millivolts to 500 volts	Calibrate accuracy of output
Keithley Instruments Model 6601A Voltage Divider, 100:1, 100 volts to 5000 volts, ±0.01% accuracy	Calibrate accuracy of output

TABLE 3. Equipment Recommended for Model 242 Calibration. Use these instruments or their equivalents.

d. Repeat the 3500 and 300-volt adjustments until there is no discrepency between the Model 242 output setting and the Model 660A Voltmeter reading.

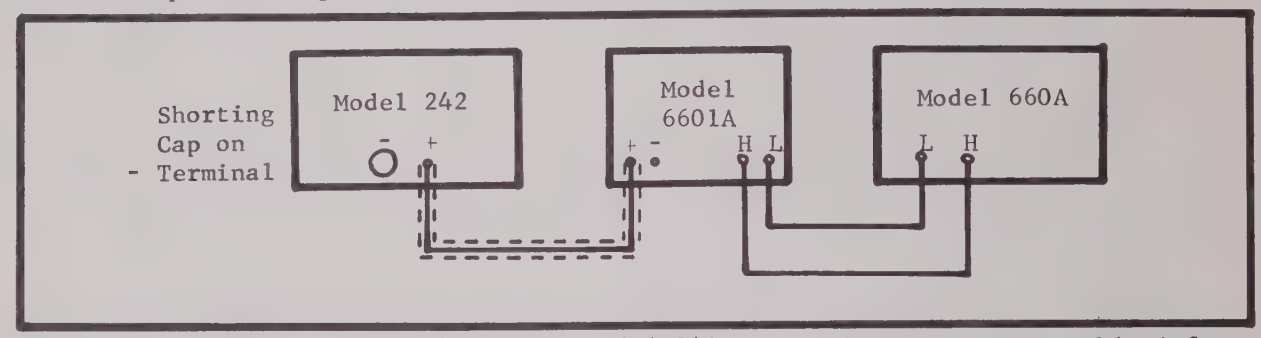

FIGURE 7. Block Diagram for Calibrating Model 242 Output Accuracy. See Table 3 for equipment. Use coaxial cable to connect the Models 242 and 6601A.

Control	Circuit Desig.	Fig. Ref.	Refer to Paragraph
Zener Adjustment	R133	9	4-7
High Voltage Adjustment	R136	9	5-3
Low Voltage Adjustment	R142	9	5-3
Bias Adjustment	R144	9	4-8

TABLE 4. Model 242 Internal Controls. The Table lists all internal controls, the figure picturing the location and the paragraph describing the adjustment.

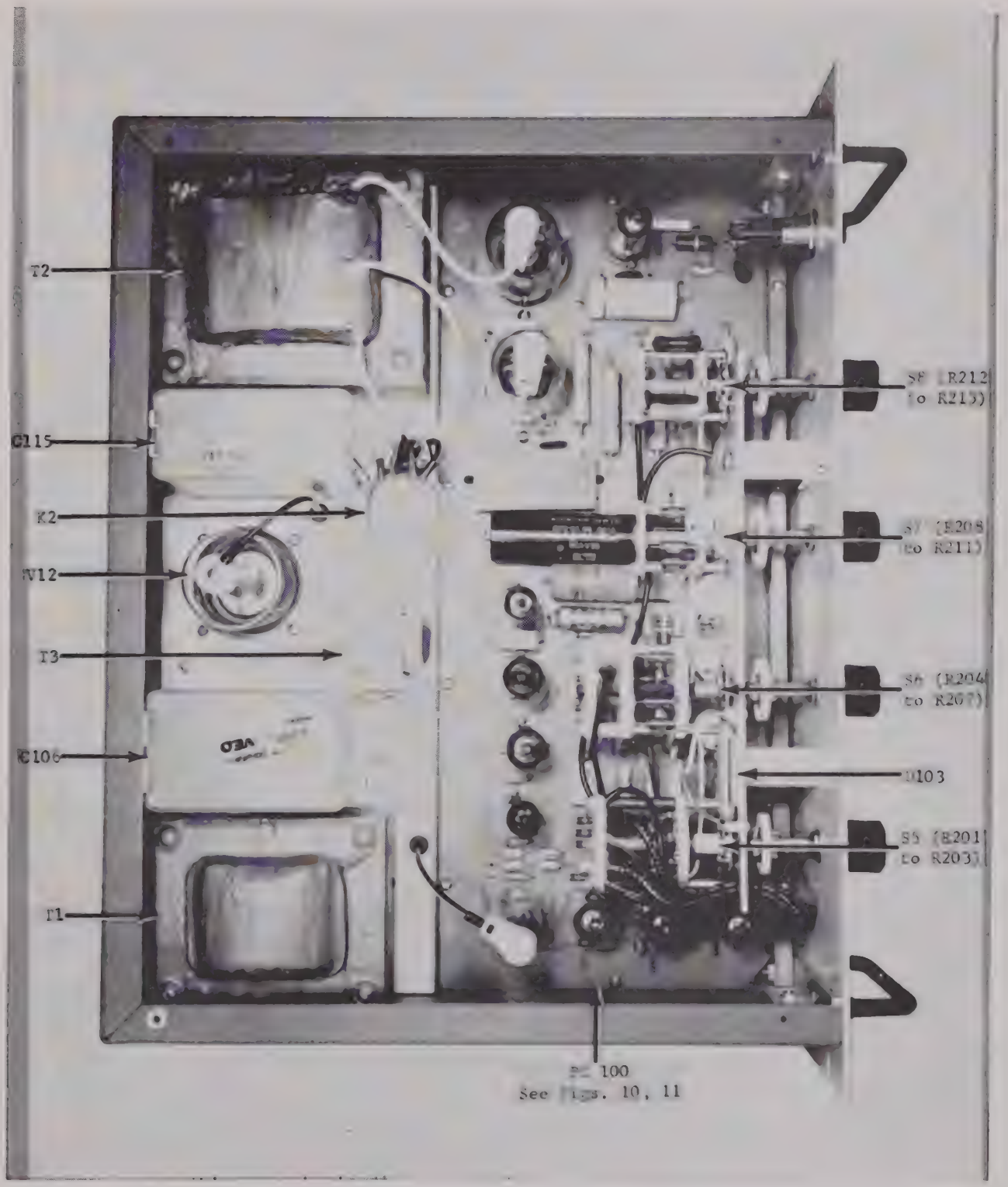

FIGURE 8. Top View of Model 242 Chassis. The illustration shows the location of components and printed circuit. Refer to Figure 9 for a bottom view.

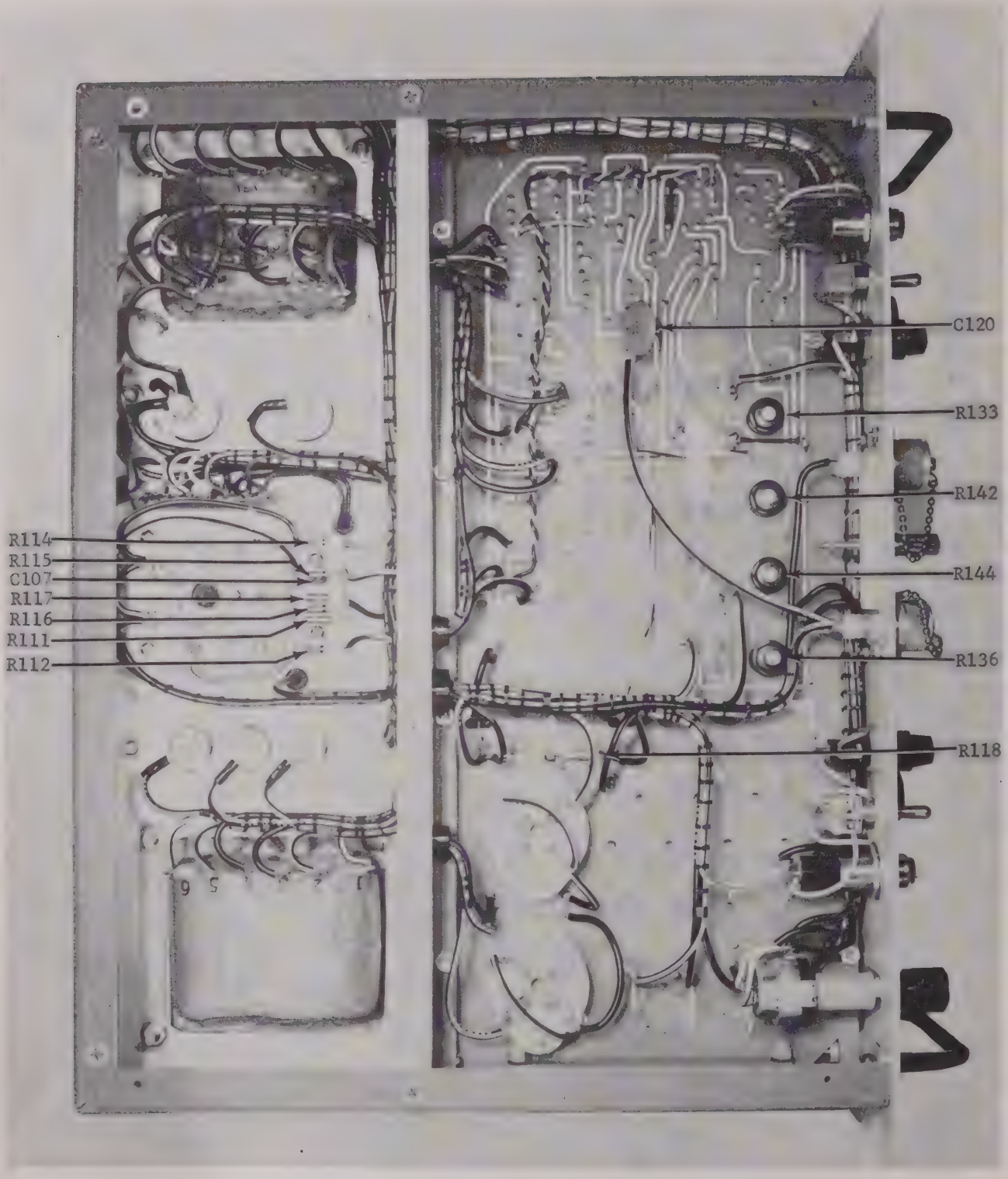

FIGURE 9. Bottom View of Model 242 Chassis. The illustration shows the location of components and internal controls. Refer to Figure 8 for a top view.

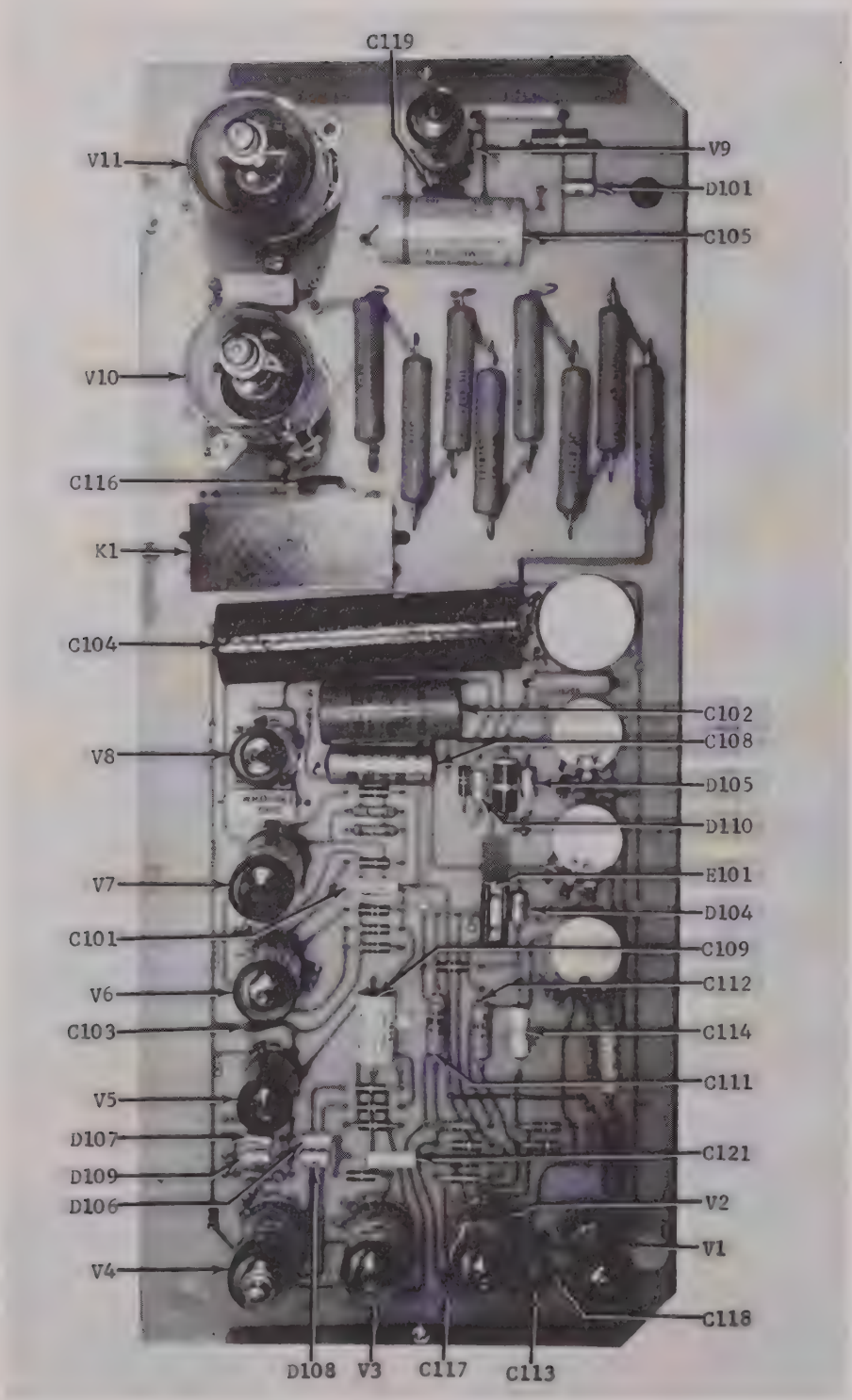

FIGURE 10. Tube, Diode, Capacitor and Modulator Locations on Printed Circuit Board PC-100. Resistors are shown in Figure 11.

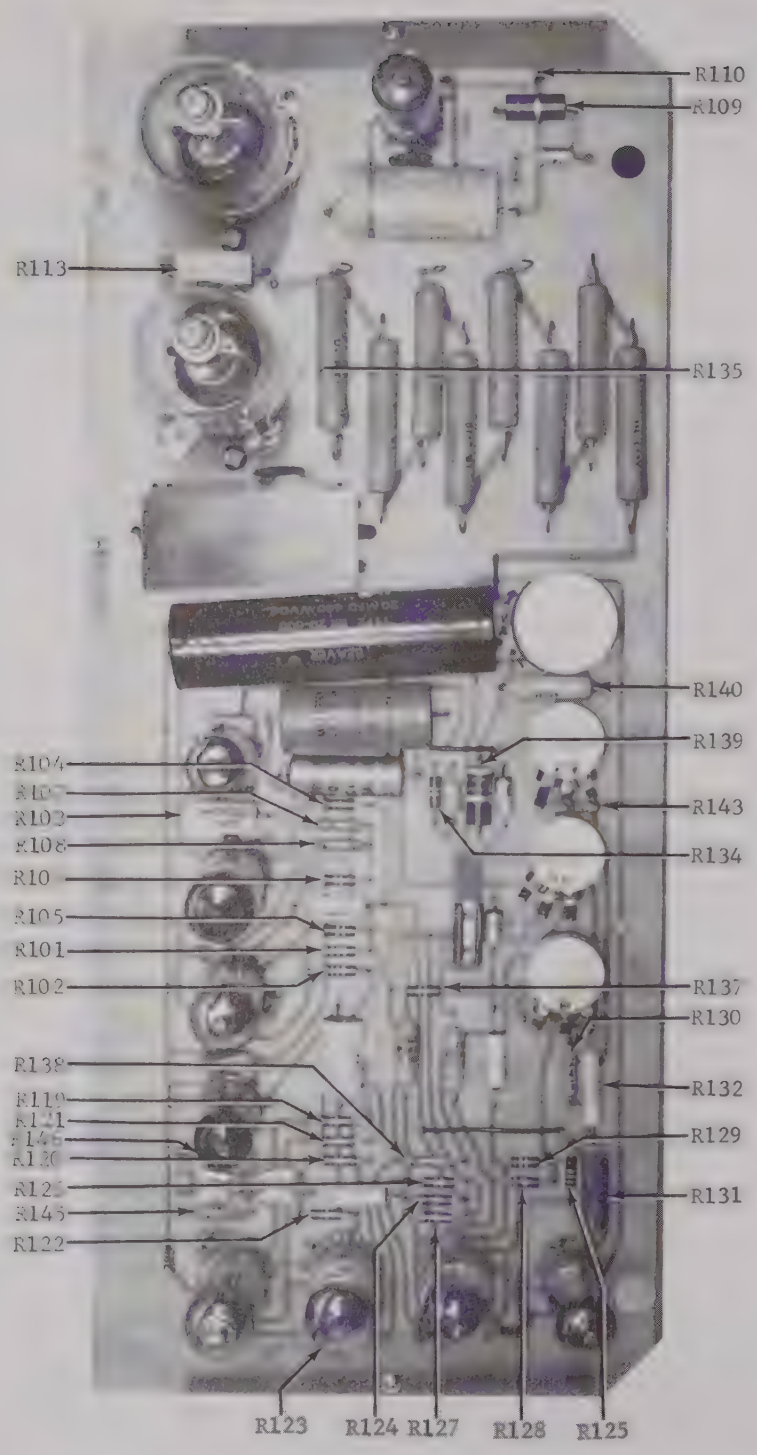

FIGURE 11. Resistor Locations on Printed Circuit Board PC-100. Other components are shown in Figure 10.

SECTION 6. REPLACEABLE PARTS

6-1. REPLACEABLE PARTS LIST. The Replaceable Parts List describes the components of the Model 242 Regulated High Voltage Supply. The List gives the circuit designation, the part description, a suggested manufacturer, the manufacturer's part number and the Keithley Part Number. The last column indicates the figure picturing the part. The name and address of the manufacturers listed in the "Mfg. Code" column are contained in Table 6.

6-2. HOW TO ORDER PARTS.

a. For parts orders, include the instrument's model and serial number, the Keithley Part Number, the circuit designation and a description of the part. All structural parts and those parts coded for Keithley manufacture (80164) must be ordered from Keithley Instruments, Inc., or its representative. In ordering a part not listed in the Replaceable Parts List, completely describe the part, its function and its location.

b. Order parts through your nearest Keithley representative or the Sales Service Department, Keithley Instruments, Inc.

amp	ampere	M or meg	mega (10^6) or megohms
		m	milli (10^{-3})
CbVar	Carbon Variable	Mfg.	Manufacturer
CerD	Ceramic, Disc	Mil. No.	Military Type Number
Comp	Composition	My	Mylar
CompV	Composition Variable		
		Ω	ohms
DCb	Deposited Carbon		
		p	pico (10^{-12})
ETB	Electrolytic, tubular		
ETT	Electrolytic, tantalum	μ	micro (10^{-6})
f	farad	v	volt
		Var	Variable
k	kilo (10^3)		
		w	watt
		WW	Wirewound
		WWVar	Wirewound Variable

TABLE 5. Abbreviations and Symbols.

MODEL 242 REPLACEABLE PARTS LIST

(Refer to Schematic Diagram 14661D for circuit designations.)

CAPACITORS

Circuit Desig.	Value	Rating	Type	Mfg. Code	Mfg. Part No.	Keithley Part No.	Fig. Ref.
C101	0.1 μf	200 v	My	02777	P-12M	C66-.1M	10
C102	10 μf	450 v	ETB	37942	TC-72	C8-10M	10
C103	.01 μf	500 v	CerD	72982	811-000-Z5UO-103M	C22-.01M	10
C104	20 μf	600 v	ETB	14655	BR20-600	C35-20M	10
C105	20 μf	350 v	ETB	56289	TVA1608	C23-20M	10
C106	.5 μf	6000 v	My	99120	LK60-504	C74-.5M	8
C107	47 pf	500 v	CerD	72982	831-000-Z5F-470M	C22-47P	9
C108	100 μf	25 v	ETB	56289	TVA1207	C10-100M	10
C109	1.0 μf	200 v	My	13050	107-21	C66-1.0M	10
C110	Not Used						
C111	2 μf	50 v	ETT	37942	TC302	C39-2M	10
C112	2 μf	50 v	ETT	37942	TC302	C39-2M	10
C113	.001 μf	500 v	CerD	72982	801-000-Z5U-001-102M	C22-.001M	10
C114	0.1 μf	200 v	My	02777	P-12M	C66-.1M	10
C115	.05-.5 μf	5000 v	My	99120	LK50-555A	C51-.05/.5M	8
C116	.02 μf	500 v	CerD	72982	841-000-Z5UO-203M	C22-.02M	10
C117	.0022 μf	1000 v	CerD	56289	5GAD22	C72-.0022M	10
C118	.01 μf	500 v	CerD	72982	811-000-Z5UO-103M	C22-.01M	10
C119	.01 μf	500 v	CerD	72982	811-000-Z5UO-103M	C22-.01M	10
C120	.005 μf	3000 v	CerD	71590	DD30-502	C75-.005M	9
C121	.1 μf	200 v	My	02777	P-12M	C66-.1M	10

DIODES

Circuit Desig.	Type	Number	Mfg. Code	Keithley Part No.	Fig. Ref.
D101	Silicon	1N3255	02735	RF-17	10
D102	Not Used				
D103	Zener	1N938	80164	DZ-6	8
D104	Silicon	1N3253	80164	*17459A	10
D105	Silicon	1N3253	80164	*17459A	10
D106	Silicon	1N3253	02735	RF-20	10
D107	Silicon	1N3253	02735	RF-20	10
D108	Silicon	1N3253	02735	RF-20	10
D109	Silicon	1N3253	02735	RF-20	10
D110	Silicon	1N3253	02735	RF-20	10

* D104 and D105 are matched; replace as a pair.

MISCELLANEOUS PARTS

Circuit Desig.	Description	Mfg. Code	Keithley Part No.	Fig. Ref.
DS1	Pilot Light Assembly, Green, POWER (Mfg. No. 5201-232)	72619	PL-56	2
DS2	Pilot Light Assembly, Red, OVERLOAD (Mfg. No. 5201-211)	72619	PL5RF	2
DS3	Pilot Light Assembly, Amber, HIGH VOLTAGE (Mfg. No. 5201-213)	72619	PL-5AF	2
—	Lamp, 3 req'd (Mfg. No. 47)	08804	PL-4	
E101	Photo Modulator	80164	1512	10
F1 (117 v)	Fuse, slow blow, 1.5 amp (Mfg. Type MDX)	71400	FU-16	2
F1 (234 v)	Fuse, slow blow, .75 amp, 3 AG (Mfg. No. 313.750)	75915	FU-14	2
F2 (117 v)	Fuse, slow blow, 2 amp, 3 AG (Mfg. No. 313002)	75915	FU-25	2
F2 (234 v)	Fuse, slow blow, 1 amp (Mfg. Type MDL)	71400	FU-10	2
—	Fuse holder, two req'd (Mfg. No. 342012)	75915	FH-3	
J1	Receptacle, hn, OUTPUT +	80164	CS-79	2
J2	Receptacle, hn, OUTPUT -	80164	CS-79	2
—	(F) Plug, hn, Mate of J1 and J2, Mil. No. UG-59A/U (Mfg. No. 82-38)	02660	CS-80	-
—	Binding Post, GND (Mfg. No. 938-A)	24655	BP-1	2
—	Cap and Chain Assembly, non-shorting (Mfg. No. 5207)	91737	CAP-15	2
—	Cap and Chain Assembly, red shorting (Mfg. No. 5816)	91737	CAP-8	2
K1	Relay, Overload	80164	RL-21	10
K2	Relay, DPDT	80164	RL-16	8
P1	Cord Set, 6 feet (Mfg. No. 4638-13)	93656	CO-5	-
—	Cable Clamp (Mfg. No. SR-5P-1)	28520	CC-4	-
T1 (117 v)	Transformer, Power	80164	TR-47	8
T1 (234 v)	Transformer, Power	80164	TR-73	8
T2 (117 v)	Transformer, High Voltage	80164	TR-48	8
T2 (234 v)	Transformer, High Voltage	80164	TR-74	8
T3 (117 v)	Transformer, Filament	80164	TR-46	8
T3 (234 v)	Transformer, Filament	80164	TR-72	8

(F) Furnished accessories.

RESISTORS

Circuit Desig.	Value	Rating	Type	Mfg. Code	Mfg. Part No.	Keithley Part No.	Fig. Ref.
R101	33 kΩ	10%, 1/2 w	Comp	01121	EB	R1-33K	11
R102	33 kΩ	10%, 1/2 w	Comp	01121	EB	R1-33K	11
R103	500 Ω	1%, 5 w	WW	63743	5X	R4A-500	11
R104	10 MΩ	10%, 1/2 w	Comp	01121	EB	R1-10M	11
R105	220 kΩ	10%, 1/2 w	Comp	01121	EB	R1-220K	11
R106	10 MΩ	10%, 1/2 w	Comp	01121	EB	R1-10M	11
R107	1 MΩ	1%, 1/2 w	DCb	79727	CFE-15	R12-1M	11
R108	600 kΩ	1%, 1/2 w	DCb	79727	CFE-15	R12-600K	11
R109	2.2 kΩ	10%, 2 w	Comp	01121	HB	R3-2.2K	11
R110	10 kΩ	1%, 5 w	WW	44655	4654	R4A-10K	11
R111	5.6 MΩ	10%, 1/2 w	Comp	01121	EB	R1-5.6M	9
R112	100 Ω	10%, 1/2 w	Comp	01121	EB	R1-100	9
R113	1 kΩ	1%, 5 w	WW	91637	RS-5	R4A-1K	11
R114	100 Ω	10%, 1/2 w	Comp	01121	EB	R1-100	9
R115	100 Ω	10%, 1/2 w	Comp	01121	EB	R1-100	9
R116	100 Ω	10%, 1/2 w	Comp	01121	EB	R1-100	9
R117	56 kΩ	10%, 1/2 w	Comp	01121	EB	R1-56K	9
R118	*235 Ω	1%, 1/2 w	DCb	79727	CFE-15	R12-235	9
R119	100 Ω	10%, 1/2 w	Comp	01121	EB	R1-100	11
R120	220 kΩ	10%, 1/2 w	Comp	01121	EB	R1-220K	11
R121	220 kΩ	10%, 1/2 w	Comp	01121	EB	R1-220K	11
R122	10 MΩ	10%, 1/2 w	Comp	01121	EB	R1-10M	11
R123	10 kΩ	10%, 1/2 w	Comp	01121	EB	R1-10K	11
R124	1 MΩ	10%, 1/2 w	Comp	01121	EB	R1-1M	11
R125	330 kΩ	10%, 1/2 w	Comp	01121	EB	R1-330K	11
R126	22 kΩ	10%, 1/2 w	Comp	01121	EB	R1-22K	11
R127	1 MΩ	10%, 1/2 w	Comp	01121	EB	R1-1M	11
R128	3.3 kΩ	10%, 1/2 w	Comp	01121	EB	R1-3.3K	11
R129	330 kΩ	10%, 1/2 w	Comp	01121	EB	R1-330K	11
R130	150 kΩ	1%, 1/2 w	DCb	79727	CFE-15	R12-150K	11
R131	5 kΩ	1%, 5 w	WW	63743	5X	R4A-5K	11
R132	10 kΩ	1%, 5 w	WW	44655	4654	R4A-10K	11
R133	5 kΩ	10%, 3 w	WWVar	37942	R5000L	RP3-5K	9
R134	220 kΩ	10%, 1/2 w	Comp	01121	EB	R1-220K	11
R135 a-h	121.875 kΩ	1%, 10 w	WW	01686	TC-10	R121-121.875K	11
R136	50 kΩ	10%, 2 w	WWVar	75042	WP	RP9A-50K	9
R137	220 kΩ	10%, 1/2 w	Comp	01121	EB	R1-220K	11
R138	7.5 MΩ	1%, 1/2 w	DCb	79727	CFE-15	R12-7.5M	11
R139	500 Ω	10%, 2 w	Comp	01121	HB	R3-500	11
R140	6 MΩ	1%, 1 w	DCb	91637	DC-1	R13-6M	11

* Nominal value, factory set.

RESISTORS (Cont'd)

Circuit Desig.	Value	Rating	Type	Mfg. Code	Mfg. Part No.	Keithley Part No.	Fig. Ref.
R141	50 kΩ	10%, 2 w	WWVar	12697	43-50K	RP32-50K	2
R142	1 MΩ	20%, 1/2 w	CbVar	75042	RQ11-137	RP2A-1M	9
R143	5 kΩ	1%, 1/2 w	DCb	79727	CFE-15	R12-5K	11
R144	20 kΩ	20%, .2 w	CompV	71450	70	RP7-20K	9
R145	100 kΩ	1%, 1/2 w	DCb	79727	CFE-15	R12-100K	11
R146	100 kΩ	1%, 1/2 w	DCb	79727	CFE-15	R12-100K	11
R201	9 kΩ	.1%, .15 w	WW	15909	1250	R11-9K	8
R202	9 kΩ	.1%, .15 w	WW	15909	1250	R11-9K	8
R203	9 kΩ	.1%, .15 w	WW	15909	1250	R11-9K	8
R204	90 kΩ	.1%, .15 w	WW	15909	1250	R11-90K	8
R205	45 kΩ	.1%, .15 w	WW	15909	1250	R11-45K	8
R206	22.5 kΩ	.1%, .15 w	WW	15909	1250	R11-22.5K	8
R207	22.5 kΩ	.1%, .15 w	WW	15909	1250	R11-22.5K	8
R208	900 kΩ	.25%, .15 w	WW	01686	7010	R10-900K	8
R209	450 kΩ	.25%, .15 w	WW	01686	7010	R10-450K	8
R210	225 kΩ	.25%, .15 w	WW	01686	7010	R10-225K	8
R211	225 kΩ	.25%, .15 w	WW	01686	7010	R10-225K	8
R212	9 MΩ	1%, 1 w	DCb	91637	DC-1	R13-9M	8
R213	4.5 MΩ	1%, 1 w	DCb	91637	DC-1	R13-4.5M	8
R214	2.25 MΩ	1%, 1 w	DCb	91637	DC-1	R13-2.25M	8
R215	2.25 MΩ	1%, 1 w	DCb	91637	DC-1	R13-2.25M	8

SWITCHES

Circuit Desig.	Description	Mfg. Code	Keithley Part No.	Fig. Ref.
S1	Toggle Switch, SPST, POWER (Mfg. No. 20994LH)	04009	SW-4	2
S2	Not Used			
S3	Not Used			
S4	Toggle Switch, DPDT, HIGH VOLTAGE (Mfg. No. 20905-FR)	04009	SW-14	2
S5	Rotary Switch less components, X1000 OUTPUT VOLTS	80164	SW-190	2
—	Rotary Switch with components, X1000 Output Volts	80164	14672B	
—	Skirted Knob, X1000 Switch	80164	14634A	
S6	Rotary Switch less components, X100 OUTPUT VOLTS	80164	SW-131	2
—	Rotary Switch with components, X100 Output Volts	80164	14669B	
—	Skirted Knob, X100 Switch	80164	13923A	

SWITCHES (Cont'd)

Circuit Desig.	Description	Mfg. Code	Keithley Part No.	Fig. Ref.
S7	Rotary Switch less components, X10 OUTPUT VOLTS	80164	SW-132	2
---	Rotary Switch with components, X10 Output Volts	80164	14671B	-
---	Skirted Knob, X10 Switch	80164	13923A	-
S8	Rotary Switch less components, X1 OUTPUT VOLTS	80164	SW-132	2
---	Rotary Switch with components, X1 Output Volts	80164	14680B	-
---	Skirted Knob, X1 Switch	80164	13923A	-
---	Skirted Knob, Trim Potentiometer	80164	KN-11	-

VACUUM TUBES

Circuit Desig.	Number	Mfg. Code	Keithley Part No.	Fig. Ref.
V1	0B2	86684	EV-0B2	10
V2	12AX7	80164	EV-12AX7	10
V3	12AX7	80164	EV-12AX7	10
V4	7235	86684	EV-7235	10
V5	0G3	73445	EV-0G3	10
V6	12AX7	80164	EV-12AX7	10
V7	12B4A	85599	EV-12B4A	10
V8	6X4	81453	EV-6X4	10
V9	0B2	86684	EV-0B2	10
V10	3B24W	86684	EV-3B24W	10
V11	3B24W	86684	EV-3B24W	10
V12	4-65A	06980	EV4-65A	8

01121	Allen-Bradley Corp. Milwaukee, Wis.	02777	Hopkins Engineering Co. San Fernando, Calif.
01686	RCL Electronics, Inc. Riverside, N. J.	04009	Arrow-Hart and Hegeman Electric Co. Hartford, Conn.
02660	Amphenol-Borg Electronics Corp. Broadview, Chicago, Illinois	04713	Motorola, Inc. Semiconductor Products Division Phoenix, Arizona
02735	Radio Corp. of America Commercial Receiving Tube and Semiconductor Division Somerville, N. J.	06980	Eitel-McCullough, Inc. San Carlos, Calif.

TABLE 6 (Sheet 1). Code List of Suggested Manufacturers. (Based on Federal Supply Code for Manufacturers, Cataloging Handbook H4-1.)

08804	Lamp Metals and Components Department G. E. Co. Cleveland, Ohio
12697	Clarostat Mfg. Co., Inc. Dover, N. H.
13050	Potter Co. Wesson, Miss.
14655	Cornell-Dubilier Electric Corp. Newark, N. J.
15909	Daven Division Thomas A. Edison Industries McGraw Edison Co., Livingston, N. J.
24655	General Radio Co. West Concord, Mass.
28520	Heyman Mfg. Co. Kenilworth, N. J.
37942	Mallory, P. R., and Co., Inc. Indianapolis, Ind.
44655	Ohmite Mfg. Co. Skokie, Ill.
56289	Sprague Electric Co. North Adams, Mass.
63743	Ward Leonard Electric Co. Mount Vernon, N. Y.
71400	Bussmann Mfg. Div. of McGraw-Edison Co. St. Louis, Mo.
71450	CTS Corp. Elkhart, Ind.
71590	Centralab Division of Globe-Union, Inc. Milwaukee, Wis.
72619	Dialight Corp. Brooklyn, N. Y.
72982	Erie Technological Products, Inc. Erie, Pa.
73445	Amperex Electronic Co. Division of North American Philips Co., Inc. Hicksville, N. Y.
75042	International Resistance Co. Philadelphia, Pa.
75915	Littelfuse, Inc. Des Plaines, Ill.
79727	Continental-Wirt Electronics Corp. Philadelphia, Pa.
80164	Keithley Instruments, Inc. Cleveland, Ohio
81453	Raytheon Co. Industrial Components Div. Industrial Tube Operation Newton, Mass.
83125	General Instrument Corp. Capacitor Division Darlington, S. C.
85599	Tube Department G. E. Co. Schenectady, N. Y.
86684	Radio Corp. of America Electronic Components and Devices Harrison, N. J.
91637	Dale Electronics, Inc. Columbus, Nebr.
91737	Gremar Mfg. Co., Inc. Wakefield, Mass.
91929	Minneapolis-Honeywell Regulator Co. Micro Switch Division Freeport, Ill.
93656	Electric Cord Co. Caldwell, N. J.
99120	Plastic Capacitors, Inc. Chicago, Ill.

TABLE 6 (Sheet 2). Code List of Suggested Manufacturers. (Based on Federal Supply Code for Manufacturers, Cataloging Handbook H4-1.)

CHANGE NOTICE

March 21, 1966

MODEL 242 VOLTAGE SUPPLY

Page 19. Change to the following:

-----	Cap and Chain Assembly, red shorting	80164	19547A	2

Page 21. Change to the following:

Circuit Desig.	Value	Rating	Type	Mfg. Code	Mfg. Part No.	Keithley Part No.	Fig. Ref.
R142	2 MΩ	20%, 1/2 w	CbVar	75042	RQ11	RP2A-2M	9

Circuit Desig.	Number	Mfg. Code	Keithley Part No.	Fig. Ref.
V2	7025	80164	EV-7025	10
V3	7025	80164	EV-7025	10
V6	7025	80164	EV-7025	10

Schematic Diagram 14661D.

Change the value of R142 to 2M. Change the number of V2, V3 and V6 to 7025.

CHANGE NOTICE

March 21, 1956

Page 19. Change to the following:

------	Cap and Chain Assembly, red aborting	80164	1954?A	2

Page 21. Change to the following:

Circuit Desig.	Value	Rating	Type	Mfg. Code	Mfg. Part No.	Raytheon Part No.	Fig. Ref.
R142	2 MΩ	20%, 1/2 w	CbVar	71042	R011	RP24-2M	9

Circuit Desig.	Number	Mfg. Code	Raytheon Part No.	Fig. Ref.
V2	7025	80164	RV-7025	10
V3	7025	80164	RV-7025	10
V6	7025	80164	RV-7025	10

Subscription Diagram 1955?B.

Change the value of R142 to 2M. Change the number of V2, V3 and V6 to 7025.

KEITHLEY INSTRUMENTS, INC.
12415 EUCLID AVENUE CLEVELAND, OHIO 44106